NATURAL RESOURCES CONSERVATION SERVICE
(NRCS)

(210-AWMFH, Chapter 13, OH-8, 3/00)
ANIMAL COMPOSTING

LIVESTOCK MORTALITY COMPOSTING
Operation & Maintenance Plan
Bin Composting With Sawdust
(Includes poultry composting section)

Owner _____ County _____ Date _____

Type of Livestock: Dairy/Cattle Horses Poultry Sheep/Goats Swine

Design Mortality (lb/day): _____

Design Carcass Weight (lb): _____

Primary Cycle _____ days (10 day min), Secondary Cycle _____ days (10 day min)

1. Composting is a controlled natural process in which beneficial microorganisms reduce and transform organic wastes into a useful end product (compost). It is an aerobic process that does not produce offensive odors, and does produce a final product that is safe and is valuable as a crop fertilizer.

2. This method utilizes sawdust as the bulking agent and allows the dead animal to supply the necessary nitrogen and water for the composting process to take place. This will satisfy the requirements of certain readily available bacteria and fungi to convert these materials to an inoffensive and useful product. The volume of the mass will be reduced 25 to 30 percent by the process. The composting process consists of a primary and secondary stage. The primary stage is to reduce the carcass to where only larger bones remain. The secondary stage is to allow complete decomposition of the carcass and for the compost to stabilize. The composting time is dependent upon the size of the carcass. Therefore it is best to group similar sized carcasses into the same bin. The time for secondary composting should generally be about 1/3 the time of primary composting. The following table can be used to estimate the cycle times for various sized animals.

Carcass size (lbs).	5	10	25	50	100	220	350	500	1000	1500
Primary cycle (days)	10	16	25	35	50	75	95	115	160	195
Secondary cycle (days)	10	10	10	12	15	25	30	40	55	65

3. Start a composting bin by placing a minimum one foot of sawdust on the floor of the primary bin; if the carcass weight exceeds 200 Lbs, use at least 1½ feet of sawdust at the base. Carcasses placed directly on soil, gravel, or concrete floors will NOT compost. Place one layer of dead animals on the sawdust and cover with a minimum of 1 foot of sawdust. Place no animals closer than 1 foot from the side of the bin. The 1 foot cover on the sides and on top is important to eliminate scavenging animals and minimize odors. Most problems in animal composting arise when insufficient sawdust is used in covering carcasses. Small animals less than 20 pounds may be grouped. Larger animals may need to be recovered as the sawdust settles around the carcass.

To place additional carcasses, "hollow-out" a cavity in the existing compost, place the carcasses one animal thick and cover with a minimum 1 foot sawdust. If finished compost is available, it should be used to cover the carcass to provide additional heat and bacteria to start the process. Sawdust should then be used to provide the final cover. Use a pointed dowel or rod to measure the thickness of the sawdust cover. Do not put carcasses on top of carcasses. Maintain 1/2 to 1 foot between carcasses to prevent a large anaerobic mass.

4. It is recommended to monitor temperatures in the bin with a long stem, dial type thermometer. When composting is proceeding properly, temperatures will reach 130 to 160 degrees F. Other than testing, this is the best way to prove pathogen kill. Primary bins started during cold weather may not begin composting immediately. If carcasses are buried with the proper amounts of sawdust, they will begin composting as temperatures warm up. There is usually enough heat in active compost to continue composting through cold weather, regardless of the ambient temperature. If sawdust is used as recommended, the insulation effect is sufficient to minimize the effects of ambient temperature. However during cold weather, incorporate mortalities into the compost as soon as possible. Frozen carcasses will take very long to compost.

5. After the primary bin has composted for the “primary cycle time” (after adding the last animal), turn the contents into the secondary bin. This step provides mixing and aeration of the material so it will reheat and compost through the secondary cycle.

6. After the secondary cycle has completed, the compost should appear as a dark humus type material with very little odor. Some resistant parts such as teeth may still be identifiable, but should be soft and easily crumbled. If not, reintroduce them to the primary bin. After completion of the secondary cycle, the compost can be recycled. or spread as per the utilization plan. Storage of compost for at least 30 days following completion of the secondary cycle will give additional management flexibility. This is particularly important where the primary plus secondary cycle is less than 90 days since land application may not be possible immediately following the secondary cycle.

7. Use the finished compost for a starter material over the new carcasses composted in the primary area. This provides heat and bacteria to kick start the process. Experience has shown that up to 50% of the sawdust requirements can be filled using recycled, finished compost. However, plan to use sawdust in the amounts noted for starting up the composting operation until sufficient finished compost is available. It is important to recognize that as finished compost becomes available, 50% of the sawdust requirement must be maintained for the system to function effectively.

8. Keep fresh sawdust as dry as possible. Sawdust in the range of 40 to 50 percent moisture is recommended.

If other bulking agents such as corn stover or chopped straw are used in the bin, moisture loss will be more prevalent than with sawdust. A supplemental water source will be necessary to maintain the proper moisture content necessary for composting.

9. Keep the area around the bins mowed and free of tall weeds and brush. Watch for any leaching that may occur. Using sawdust for the foundation in the primary bins will help eliminate leaching. There should be no leaching in a covered bin composting system.

10. Finished compost should be applied to supply N, P_20_5 and K_20 requirements. The nutrient requirements for any particular crop should be based on a current soil test. Compost application rates should be calculated on its nutrient content according to a recent laboratory analysis. In the absence of a laboratory analysis the nutrient content of the compost is estimated to be:

Total Nitrogen	-20 lbs/ton
Ammonia Nitrogen	-4 lbs/ton
Phosphorus	- 2 lbs/ton
Potassium	- 6 lbs/ton

Finished compost shall be applied as per the compost utilization plan.

11. In order to assure desired operation of the composting facility, daily records should be kept during the first several compost batches. This can be helpful in identifying problems that may occur. Record keeping can be discontinued when a desirable level of operation has been achieved. It is suggested to record daily, the amount of sawdust added, the weight of the animals, and the temperature of the compost.

12. Occasionally, composters will not heat up, or will produce odors or seepage. Composting is a biological process that depends on providing nutrients and an environment favorable for vigorous bacterial growth. Common mistakes are, failure to provide all the materials needed for energy and aeration, sloppy loading, insufficient cover over the animals, insufficient sawdust between the animals. These mistakes typically result in a dense, anaerobic mass and one in which energy is limiting. Turning the compost and adding DRY sawdust will remedy these problems. Daily records are the best way to diagnose problems.

13. Maintain all runoff control to keep the site high and dry. A wet composting facility will be prone to failure.

14. Animals digging into the compost CAN be a problem although usually not a problem in bins. Measures must be taken if this occurs for biosecurity reasons and maintaining a positive public perception. Maintaining 1 of cover over all animal parts in the bin will eliminate scavenging animals. NEVER allow animal parts to be exposed. Once an animal finds an exposed part, they are more likely to come back and dig into the compost. It is important to maintain continuous cover. Operation and management will determine the needs of the system.

15. Inspect the compost structure when it is empty. Replace any broken or badly worn parts or hardware. Patch concrete floors and curbs as necessary to assure proper operation and integrity. Examine roofed structures for structural integrity and leaks.

16. Keep all trees, shrubs, and flowers healthy in order to maintain a positive rural image.

Additional Considerations for Poultry Mortality Composting

1. The process uses a simple mixture of poultry manure, poultry carcasses, straw, and water. This will satisfy the requirements of certain readily available bacteria and fungi to convert these materials to an inoffensive and useful compost. The volume of the mass will be reduced 25 to 30 percent by the process.

Recipe of Material Proportions for Poultry Composting

Material	Parts by Weight
Poultry Carcasses	1.0
Poultry Litter	1.2
Straw	0.1
Water	0.75

2. Once the weight of a day's poultry carcasses is determined, the other elements can be weighed out according to the recipe. The elements should be weighed in buckets on scales for the first few batches. For subsequent batches, a loader can be used once the weight of a full loader bucket has been determined for each element except water. A hose can be used to deliver the correct amount of water based on the time necessary to deliver the required weight of water through the hose. The moisture content must be maintained between 40 and 60 percent, equivalent to that of a "damp sponge." This is an important part of the composting process, since a mixture that is too wet can become anaerobic and cause severe odor problems. Additional water may not be needed if sufficient moisture is available from other recipe ingredients.

3. For primary composting, the material is placed in the bins in layers in the following sequence: (Note: see Figure 1)

   a. One foot of dry poultry manure should be placed on the concrete floor to absorb the excess moisture that is added. This manure weight is not part of the recipe.

   b. A 6-inch layer of loose straw is placed on top of the manure layer to allow aeration under the carcasses.

   c. Add a layer of carcasses. Do not mound the birds. Use a rake to spread the birds in a single layer. Keep birds at least 6 in. away from the walls so the carcasses are not exposed.

   d. Add water to each layer of carcasses. Add water only when needed to ensure the mixture is damp. The mixture should be about as moist as a damp sponge. Proper water content is important to success. Less water may be needed as the birds approach maturity. DO NOT ADD TOO MUCH WATER.

   e. A layer of manure is placed over the carcasses according to the recipe. The manure must completely cover the chickens. This completes the first batch.

   f. The second and each subsequent batch continues by repeating steps b through e above until the bin is full.

   g. When the last layer of chickens is added to a bin, cap the pile with an extra layer of manure. The extra layer will insulate the pile and will also help prevent scavenging animals from digging into the top.

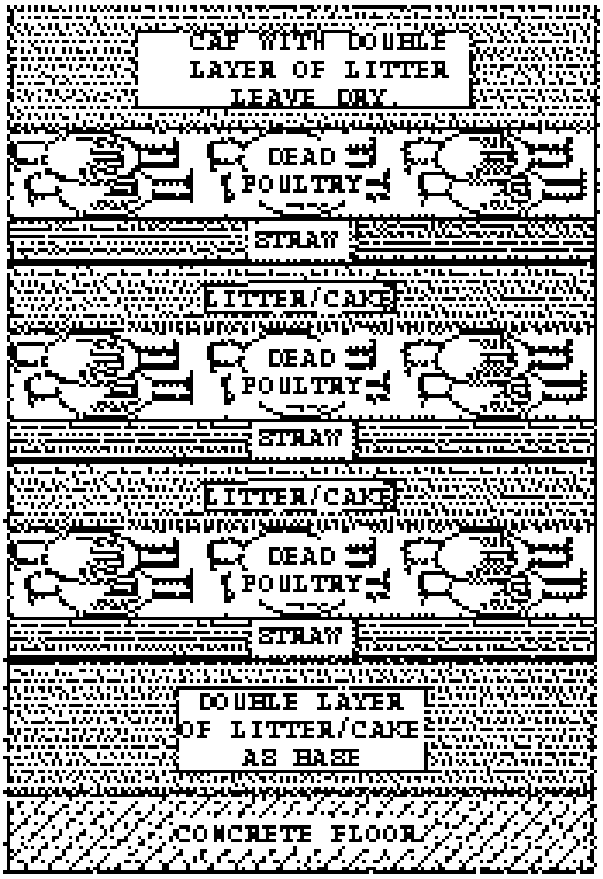

Figure 1

4. Temperature shall be monitored on a daily basis using a 36-inch probe-type thermometer with a rigid protective covering. Temperatures should peak at 130 to 140 ° F after 5 to 7 days of composting. If temperatures of 130 degrees are not achieved during the composting process, the resulting compost shall be incorporated immediately after land application. If temperatures exceed 160 degrees F, the compost shall be removed from the composting bin, spread on the ground to a depth not to exceed six inches in an area away from buildings, and saturated with water to prevent spontaneous combustion.

5. The primary composter shall be unloaded as peak temperatures begin to decline after 5 to 7 days, optimally at 10 days for chickens. For larger birds such as mature male turkeys the primary composting cycle will take from 25 to 30 days (see table on page 1). Unloading the primary composter and loading the secondary composter shall be done in a manner that assures maximum mixing of the composting material. . Moving the material aerates the mixture and revives the bacteria, allowing them to begin another cycle of heating. Temperature should rise again and peak in about 7 days.

6. Moisture and temperature requirements discussed in paragraphs 4 and 5 above, also apply to the secondary composting process. The compost removed from the secondary composting process should be stored for 30 days before land application. Storage depth shall not exceed seven feet to reduce the potential for spontaneous combustion (see Preventing Fires in Litter Storage Structures discussion). In addition, the compost should not come in contact with any manure stored in the same facility. Storage will allow the compost to dry allowing greater ease in handling.

7. Compost shall be applied to supply N, P205 and K20 requirements. The nutrient requirements for any particular crop should be based on a current soil test. Compost application rates should be calculated on its nutrient content according to a recent laboratory analysis. In the absence of a laboratory analysis the nutrient content of the poultry compost is estimated to be:

Total Nitrogen	-	40 lbs/ton
Organic Nitrogen	-	28 lbs/ton
Phosphorus	-	20 lbs/ton
Potassium	-	25 lbs/ton

8. To utilize the nutrients in compost for crop production in an environmentally safe manner, it is important to follow the waste utilization details outlined in your Waste Utilization Plan.

9. Inspect compost structure at least twice annually when the structure is empty. Replace any broken or badly worn parts or hardware. Patch concrete floors and curbs as necessary to assure water tightness. Examine roof structures for structural integrity and leaks.

10. As discussed in paragraph 3 above, maintaining the moisture content between 40 and 60 percent is vitally important. The primary and secondary composters and the storage or "resting" area should be protected from outside sources of water such as rain or surface runoff.

11. In order to assure desired operation of the composting facility, daily records should be kept during the first several compost batches. This can be helpful in identifying problems that may occur. Record keeping can be discontinued when a desirable level of operation has been achieved. It is suggested that daily records be kept on the attached "Poultry Composting Record Worksheet."

Occasionally, composters will not heat up, or produce odors or produce seepage. Composting is a biological process that depends on providing nutrients and an environment favorable for bacterial metabolism. Common mistakes are failure to provide all the materials needed for food and aeration, or sloppy loading of primary boxes so that materials are not "sandwiched." Too little straw (or alternate carbon source" results in a dense, anaerobic mass and one in which energy (from cellulose) is limiting. Too much water is a common problem. Saturated compost piles are anaerobic and will not support the desired aerobic, thermophilic metabolism needed for rapid, odorless digestion of carcasses. If the mixture is too wet or too dry, the decomposition rate is greatly reduced. Too-wet, too dry, improperly mixed or incomplete mixes of compost materials can be amended. When primary compost is turned, dry manure or straw may be added to too wet compost, water can be added to "dusty-dry" compost, and improperly mixed materials can be remixed. A little experience and perseverance usually give good results in a short time.

Preventing Fires in Litter Storage Structures (from NRCS Alabama Guide Sheet 313)

DEFINITION

Litter stacks and even dead animal compost can catch fire if not properly maintained. Storing poultry litter in a covered storage structure is a good management technique. It provides flexibility in timing applications to the land; prevents the possibility of polluting surface or ground waters, as could occur with litter stored outdoors; and is a good way to maintain quality feed for cattle. However, careful management must occur to prevent fires.

OPERATION AND MAINTENANCE

Background Information

It has long been known that heat is generated when microbiological activity occurs in an insulated environment, such as a garden compost pile or even dairy manure stored outside. Overheating and spontaneous combustion in hay barns, coal piles, land fills, and barrels of oily rags are not uncommon. Both biological and chemical factors may be associated with litter storage fires, although the exact causes are not fully known.

Fires and explosions have occurred in unvented sanitary landfills due to the generation of combustible methane. In order for methane to be generated, conditions must be right for the growth of anaerobic bacteria. This includes proper moisture content (greater than 40%) and an oxygen-free or low-oxygen environment. Methane has a specific gravity less than air and, therefore, can escape to the atmosphere if a proper conduit is provided (i.e., adequate pore spaces in the surrounding litter). Methane is flammable in air at concentrations of 5 to 15 percent. As such, the production of methane in litter storage is a potential hazard.

Another phenomenon, called the heat of adsorption, can occur when dry matter such as litter comes into contact with moist material or even moist air. As the dry material adsorbs water vapor, heat is released. In an insulated environment this generated heat can be significant. The heat from this process begins to dissipate when the moisture occupies or is adsorbed to all the available attachment sites in the dry material.

However, another process, called pyrolysis or heat of oxidation, can take over at higher temperatures, usually between 250° to 400°F. This process is self-sustaining as long as adequate oxygen is available.

Thus, the processes which relate to the generation of heat are both biological and chemical. However, since most bacteria are killed between 130° and 165°F, chemical reactions are ultimately responsible for the processes that lead to combustion.

The Delaware NRCS, Cooperative Extension Service, and Conservation Districts conducted a survey of poultry producers to identify management practices which tended to cause fires and overheating in dry stacks. Eighty producers were interviewed. They found that seven dry stacks had experienced one or more fires. An additional twelve experienced excessive heat during the storage period. A statistical analysis did not reveal a single common cause of all fires, but it did reveal that common factors were prevalent in nearly all cases.

Study Findings

MOISTURE: Moisture was found to be a critical factor in all manure pile fires. All structures having fires had litter from houses with plasson waterers or water troughs in some or all the houses. One pile was also exposed to wind-driven rain. These findings suggest that higher moisture levels caused more heat to be generated in the piles.

LAYERING: Piles which experienced fires were all layered either horizontally (new litter stacked on top of old) or at an angle (litter pushed against the sloping sides of old litter). (NOTE: Layering brings into contact old litter which can be very dry and new litter that may be moist. The boundary between the two layers becomes an insulated, heat-producing area.)

COMPACTION: The majority of piles that experienced fires were compacted. Heat is not easily released from a compacted pile.

PILE SIZE: The pile height and width were found to be more critical than pile length. The larger the pile size (cross sectional area) the greater the chance for excessive heat or fire. Heat is more easily released from a smaller pile because of its larger ratio of surface area to volume.

RECOMMENDATIONS

In order to reduce the potential for fires in litter storage structures the following is recommended:

1. Pile height should not exceed 7 feet. Storing the material in separate small windrows reduces the cross sectional area and is the safest option for stacking.

2. KEEP THE LITTER DRY! Don't wet the litter in the hope of preventing a fire; just the opposite may occur. In addition, protect the litter from blowing rain.

3. Avoid placing the wet material in contact with dry material. Don't layer new litter on top of old, and don't let dead poultry compost come into contact with stored litter.

4. Don't compact the material by driving over it or packing it with equipment.

5. If litter is stored against wooden walls, limit height to 4 feet and monitor temperatures in this area daily. If temperatures cannot be monitored regularly, do not store litter against wooden walls.

6. Monitor temperatures at different points in the pile frequently. If temperatures exceed 190°F, or if the material is smoldering, prepare to remove material from the building. This includes notifying the local fire department to be on hand. A smoldering pile could burst into flames if exposed to air. A garden hose could be inadequate to extinguish the fire.

7. Do not store expensive equipment in the litter storage structure.

The following is an acknowledgement by the landowner and operator of the operation and maintenance requirements, support from the Natural Resources Conservation Service, and approval by the local Soil and Water Conservation District.

Signatures

Landowner_____ Date_____

Operator_____ Date_____

NRCS_____ Date_____

SWCD_____ Date_____

Frequently Asked Questions

In answering questions, if answer applies to either a windrow or bin system the word pile is often used.

1. Doesn't a dead animal compost facility produce offensive odors, and attract rodents & dogs?

If carcasses are properly covered with two feet of sawdust, odors are sufficiently suppressed or absorbed so they are not a problem in most cases. When properly operated and managed, composters do not add to or increase odor levels around a production facility. Using too little sawdust is the single greatest factor associated with odor and rodent or scavenger problems. It is important to prevent these problems during start up because once scavengers learn the composter is a source of carcasses, they can be difficult to stop.

2. What happens during the winter when temperatures are cold?

In general the warmer the ambient temperature, the better the composting process works. However, an active compost pile contains considerable heat which, with the insulating effect of sawdust, minimizes the effects of ambient temperatures. Interior pile temperatures of 130 to 160 degrees F are typical in properly operating composters when ambient temperatures are as low as zero degrees F. Cold or frozen carcasses placed in cold, fresh sawdust will not compost during cold weather. However, carcasses placed under these conditions will begin to compost as ambient temperatures increase in the spring.

Carcasses placed in an active compost pile during cold weather should begin to compost as heat is absorbed from the composting mass. Covering the carcasses with warm or hot finished compost from an active secondary pile will further enhance the composting of fresh carcasses in cold ambient temperatures.

3. Is a roof and concrete floor necessary?

It has been shown that a roof is not necessary when sawdust is used as the bulking agent. Sawdust has the unique ability to shed water and if kept on a dry and well drained base, will not cause leachate. *Until research proves otherwise, a roofed structure will be required unless, 1. sawdust is used as the bulking agent, and 2. an all weather, dry, positively drained composting surface is used and all weather access is maintained, and 3. the runoff and any possible leachate are collected and stored or treated in a storage or filter area.*

4. How large a carcass can be put in a composter.

Mature sows and boars (300 to 600 lb) and cattle (>1000 lb) have been successfully composted. Longer composting times are required for the larger carcasses. However, four months of active composting time should be sufficient for most swine carcasses. The carcasses are composted whole, no cleaving or cutting up is necessary. If certain parts such as the skull or ball joints are not fully composted, reintroduce them to the primary composting process for another cycle. If this is happening a lot, look for reasons the process is being slowed. Many times it is because not enough sawdust is being added to the system.

5. Do composters fail, and why?

Occasionally, yes. Composters may not heat, producing odors and/or creating seepage. Composting is a biological process that depends on providing nutrients and an environment favorable for bacterial decomposition. *Common mistakes are: 1. failure to provide enough sawdust to the system to provide for the bio-filter and to maintain an appropriate carbon source for the system to operate over time, or 2. placing carcasses too close together may create a large anaerobic mass that will need to be turned and dry sawdust added.*

- In windrow composting the pile must be well rounded to shed water and the base must be well drained and solid to allow for access and prevent anaerobic conditions.
- The problems with, too-wet, improperly mixed, or incomplete mixes of compost materials can be amended. When primary compost is turned, dry sawdust may be added to wet compost, and improperly mixed materials can be remixed. A little experience and perseverance usually give good results in a short time.

6. Can finished compost be used as a partial or full substitute for fresh sawdust in the primary windrow?

Experience to date indicates that up to 50% of the fresh sawdust requirement may be fulfilled with finished compost. The long-term viability of the process cannot be maintained if fresh sawdust is not added, because the source of carbon would eventually be exhausted. Advantages of recycling finished compost include: less fresh sawdust required, active bacteria and heat available in the finished compost, and less finished compost to haul for land spreading.

7. What about diseases, flies, and pathogens?

Fly breeding has not been a problem with composters. However, if positive drainage is not maintained, or rutting or ponding of water occurs, or the windrow is above 60 % moisture, flies will be a problem. The answer is the proper location and construction of the composting area so there is no free standing water, positive drainage is maintained to the collection area, and the windrows are rounded.

Exposed carcass parts will invite flies and scavengers, compromising biosecurity. Properly covering all carcasses with two feet of sawdust is critical.

Temperatures will rise above 135 degrees F for greater than a three day period, which has been shown to eliminate pathogens associated with swine production. No disease outbreak has been associated with composting to date. It is recommended that composting occur on site, eliminating the spread of disease associated with transporting dead stock. Spreading finished compost on fields or pastures helps assure that disease organisms do not find their way back to the production area.

8. What should finished compost look like?

Properly finished compost should appear as a dark granular material resembling humus or potting soil. It should have the feel of moist soil. It may have a slight musty odor. Some resistant bones will be visible, but they should be soft and easily crumbled.

9. If I do not have sawdust available, can I use another carbon source?

YES, if you plan to compost in a roofed structure. If you plan to compost without a roof, until research discovers otherwise, sawdust is the only acceptable carbon source in Ohio to legally compost without a roof.

Any granular organic material with a high carbon content should be a candidate as an ingredient in composting. Successful swine composting without the use of a roofed structure has been accomplished using sawdust as the bulking agent or carbon source. More research and experience is needed to evaluate other carbon sources such as straw, hay, corn stalks, or rice hulls. A long fibrous material such as cornstalks or straw would likely work better for composting if it were ground to reduce the particle size, similar to that of sawdust. This would allow the material to settle around the carcass and provide the contact needed for good bacterial activity.

Composting structures for swine have been successful utilizing straw and poultry litter as the carbon and nitrogen source. It is necessary to construct a structure with a roof, concrete floor, and concrete or treated timber walls for these systems. Their success has been documented and design criteria are available.

10. What should I do with finished compost?

Finished compost in the secondary pile, not recycled to the primary pile, should be spread as per the compost utilization plan. Conventional "beater type" manure spreaders are ideal for handling and spreading compost.

11. Can I compost in just one step, rather than moving the material from primary to secondary windrows or bins?

Moving compost from primary to secondary windrows or bins provides mixing, adds oxygen, and allows the compost to "finish off" with a high degree of breakdown. The success of the primary/secondary approach has been demonstrated in many other areas of composting, as well as mortality composting. Some producers have reported acceptable results with single step composting, but the total composting time can be longer than the primary/secondary composting time. Also, bin or windrow volume requirements are not reduced by single-step composting.

12. What about using "green" or wet sawdust?

Generally dry sawdust is better since dryer sawdust can absorb more water and contains more air space. Producers have reported success using green sawdust for some or all of the fresh sawdust requirements. Sawdust containing excessive moisture may freeze in the winter, making it difficult to handle and place around the carcasses. A compost windrow with greater than a 60% moisture content increases the risk of leachate, anaerobic activity, and fly production. Aged sawdust of 40- 50% moisture content is recommended.